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OF THE RETINAL
VESSELS.

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EYESTRAIN AND OTHER DISEASES DUE TO CROSSING, CROWDING, AND DAM- MING OF THE RETINAL VESSELS.

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AN ophthalmoscopic glance at the fundus of the normal living eye makes it evident that the vascularization and nutrition of the intraocular tissues, especially of the retina, is not only of prime importance, but that it is the first condition of vision. And the best possible vision is the *sine qua non* of the motility, safety, and success of the dependent organism in the struggle for existence. The retinal function is one of amazing delicacy; it is conditioned upon an unexampled complexity and microscopic fineness of structure, and upon a state of the highest instability of equilibrium of molecular substance. The task of nourishing and reestablishing this function, when temporarily exhausted, is of almost incredible difficulty. Phases of this difficulty throng upon the attention. For example, the eye is a closed system, and the dominating structure, the retina, must receive its arterial supply and discharge the venous blood within the million-stranded bundle of nerves called the optic nerve. To make transparent all the ocular structures from the cornea to the pigment layer of the retina has been a unique and next to impossible necessity, and

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from nonsuccess follow a score of diseases such as leucoma, cataract, etc. There is one difficulty nature could not overcome: the blood supply of the retina had to be carried by vessels made opaque by the red blood corpuscles and coursing in front of the retina. This was a necessity resulting from the condition of the "closed system" of the globe of the eye.

The normal intraocular pressure, moreover, was required to give the globe its stability of form and make the visual act a constant and certain function. The relation of this tonicity of the globe to the entrance and exit of the blood and lymph and to the passage of the blood through the retinal vessels is one of close adjustment. A too soft globe would plainly lessen the reliability of retinal response and impair the all-important image-forming function; a globe too hard would lessen vascularization, nerve function, etc.—would mean all that the word glaucoma means.

Embryologically studied, one sees how easily the retinal vessels may become anomalous. One might, indeed, describe those of each and every eye as anomalous, so unlike is one from another. But the norm, as shown in noncomplaining eyes, and in the pictures of the textbooks, brings it about that the larger trunks of the vessels do not cross over or under each other in their courses, and that a single vessel does not curl or circle so that it passes above or below itself. If such a crossing takes place the established and necessary intraocular pressure will surely tend to, or actually bring about an impaired passage of the blood within one or both the trunks concerned. Whether the impeded circulation will lessen the supply of arterial blood to the portion of the retina it normally feeds, or whether the normal

venous outflow is prevented, will, of course, depend upon the facts in each case, the peculiarities of the crossing, the location of the block, the tension of the eyeball, etc.

Ophthalmologists have evidently not been observant of these blockings or dammings, either physiologically or pathologically. Since I first suspected their existence and pathologic significance I have found them far more common than I had supposed. Although they may be so slight as to produce no serious or demonstrable symptoms, I am sure they may be so severe as to produce the greatest and longest suffering and even the life-tragedy of the patient. If the choking is of an artery, and if it is great, and if supplying the macular region, and especially of the right eye of a righthanded (and righteyed) person, the consequences will be the worst. If the impeded venous outflow is from that region the morbid results will probably be as bad, although different. The farther from the macula is the region of the impaired nutrition, the less will be the likelihood of morbid symptoms. It will be apparent that vessels carrying red blood corpuscles must not traverse the macular or perimacular spaces, and hence that here collateral or anastomotic circulation cannot, as elsewhere in the body, take up the nutrition of the part impaired by the blocked vessels.

And it is also equally plain that the blood supply is not, and by the nature of the case cannot be, wholly cut off (as in embolism or thrombosis), but only lessened.

The symptoms may be intensified, varied, multiplied, or masked by the coexistence of ametropic eyestrain.

Of the illustrative cases with certain and distinct

and logically consequent symptoms, I briefly epitomize two:

A woman, aged forty-six, for most of her life had suffered intensely from many of the typical symptoms of eyestrain. Her statements and history as related by herself seemed so exaggerated that I was at first suspicious of hysteria and a morbid pleasure in pain, or in the belief that pain existed. Study of her case and observance of the woman's character in time convinced me that there was absolutely no such mental factor present, and that the suffering was most genuinely neurologic and physical. She had been under the care of many famous ophthalmologists, none of whom had been capable of helping her; none could guess the exact nature of the disease. The patient had loyally and faithfully carried out every kind of treatment, and had worn all possible kinds of spectacles, until each physician in turn confessed himself wholly mystified and unable to give relief. Except from one other I never heard a more pitiful and harrowing tale of suffering patiently borne, of hope renewed with each new oculist or physician consulted, of bitter disappointment as no cure followed. I was to be the last!

Since she can remember the patient has had "difficulty in seeing." The closer description of the "difficulty" makes it clear that it consisted in a failure of the right eye to hold the image, or see as plainly or continuously as with the left eye. It is what I have long been accustomed to denominate as "fading image." All her life, also, the woman has had headache. For the past eight years the worst symptom has been constant pain and tenderness across the brow and a "beating" in the right eye, not lessened by any treatment. At the menstrual

period there has been no headache, but an intense pain across the eyes, with nausea but no vomiting. There have long been insomnia, indigestion, constipation, "nervousness," "fidgetiness," with the frequently allied coupling of hypertension and depression of spirits. There has been a long and harrowing history of "rheumatism," "neuritis," and an eight-months'-long constriction of the throat during which only liquids could be swallowed. There have been many other symptoms which may here be omitted.

She was formerly under the care, for five years, of Dr. —, a famous oculist, and then another man of equal repute treated her for several years. For a number of years again, another most reputable and learned man also failed to give the patient the least relief. In 1902 he ordered:

R. + Sph. 2.25 + Cyl. 0.50 ax. 80°.

L. + Sph. 2.25 + Cyl. 0.25 ax. 100°.

He plainly thought that the slight exorphoria present was a great factor, because with the above prescription he combined 1.5° prisms each eye bases in. When no relief came he at last advised tenotomy, which the woman, with a wisdom greater than that of the doctor, rightly refused. Even without the foolish prisms the glasses were not correct, overcorrecting the error for distance, and undercorrecting it for near. With failure evident, this oculist advised the patient to consult Dr. — of —, an ophthalmic surgeon of wide renown, "who," he added, "always makes a point of disagreeing with me in everything." This was done that the patient might have an entirely independent opinion. She added, with a sickly smile, that "he did disagree in every particular." But the disagreement brought no help, and then another oculist was consulted

some nine months before coming to me. He ordered:

R. + Sph. 2.00 Prism 2° B. I.

L. + Sph. 1.50 Prism 1.5° B. D.

This order was as bad as if it had been made by "the leading oculist of the city."

Without a mydriatic I estimated the error of refraction to be:

R. + Sph. 1.62 + Cyl. 0.62 ax. 180° = 20/50+

L. + Sph. 1.37 + Cyl. 0.37 ax. 180° = 20/30?
2° B. I., 1° B. D. L.

There was also evident subnormality of accommodation. With paralyzed accommodation the errors were found to be:

R. + Sph. 2.00 + Cyl. 0.50 ax. 180° = 20/50+

L. + Sph. 2.00 + Cyl. 0.37 ax. 180° = 20/30?

With all the woman's good will to do as advised she could not and would not try bifocal spectacles, because she had by bitter experience demonstrated that they only increased her symptoms. This fact was a hint to my mind, and one which stuck there, that there was in this case an unsolved problem. I gave proper distance glasses with "fronts" for near, but the "unbearable pain" lessened no whit. In a few weeks the error was not different, and I demanded bifocals, to be used at meals, and in the house. She vowed she "could not see with them." I did not then suspect the reason they increased difficulty and pain, but this became apparent when with search and study I found that she closed the right eye when reading and ignored its image for distance, and that she "had done this for years," as she now confessed. I was now on the heels of the mystery.

At the first visit in using the ophthalmoscope I spoke of a curious loop in the superior tem-

poral artery of the right eye. The patient said: "Oh, everybody has noticed that," but adding that it had no significance. The artery close to the disc turned upon itself, forming a circle about 10° in diameter, and passing under itself proceeded onward toward the macula. But in passing beneath the vessel was flattened by the pressure of the vessel above it, and from that point the artery was pale, half collapsed, and evidently carrying but a small quantity of blood. The macula was stippled and somewhat morbid in appearance, but otherwise the eye ground seemed normal. My glasses had given no relief; there was a decided tendency to shut the right—the naturally dominant and important dextral eye—out of function; no device had given hope; the sub-normality of accommodation of the right eye was about 1 D. greater than in the left eye—a significant fact; the amblyopia had not bettered under proper glasses; the symptoms, partly those due to eyestrain, were so peculiar as to arouse suspicion that more than ametropia was the matter,—such were the conditions which directed attention to the hitherto neglected looping of the upper macular artery, and the plainly lessened blood supply of the retinal area supplied by it. I at once ordered a blinder worn nearly constantly before this eye. A more certain test would have been a bandage, because, according to the physiologic law of imperative function, the right eye must struggle for life and dominancy during all the years it is dying. In a few weeks the report was that while there was not by any means complete comfort, there had been a decided lessening of the severity of the pain, etc. The most significant fact was this: While the blinder was worn there was

comparative freedom from pain, etc., but when it was removed a throbbing pain came on, which did not disappear until the blinder had been worn again for an hour. I then knew my theory was correct and that there was nothing left but to exclude the ailing eye from function. A large black lens was provided to be worn absolutely constantly, and progressive relief is being secured. I do not look for entire happiness in this case, because too great injury has been done, and the exclusion of the right eye from function can never be complete; it must still desire or be forced to partial life and function because it is the right eye, and because its exclusion comes so late in life. The less of two tragedies is chosen, and that is often the command of practical medicine or ethics.

The moral of the tale is that knowledge of the nature and cause of an incurable disease is infinitely better than blind groping in the darkness and false, mischosen, and misapplied methods of cure.

My second case was that of a healthy strong young man of twenty, who began having "inability to use his eyes" when he was about eight years of age. Since this time there has been a continued blepharospasm, a rapid closing and opening of the lids; the lids are nipped down tight and held almost as long as they are kept open. He has not had any of the usual reflexes such as headache, dyspepsia, "migraine," etc., and no amount of questioning is able to elicit any more definite or satisfying details as to the nature of his troubles than that "things disappear," "fade out," etc., and he could not now read, write, or study. Do what he would he could not use his eyes for constant or near work. From ten to fifteen he went to school for about two

months at the beginning of the year, but after that had to stay at home or travel. At fifteen he kept at school for a year, but since then has lost every other year, "not on account of health, but because of impossibility of using his eyes."

Oculist No. 1 was consulted at the age of nine, and his glasses were worn for six months, with no relief.

Oculist No. 2 changed his glasses, and these were worn two years, but without aiding the patient to study.

Oculist No. 3 was consulted at the age of twelve with some benefit.

Oculist No. 4 changed the prescription, and these glasses were worn for but a little while. He now went two years before consulting

Oculist No. 5, who told him nothing was the matter with his eyes. But on attempting to resume study he was at once compelled to stop.

Oculist No. 6 "tried and tried" to make it possible for the patient to study. Failing, he sent him off to "the leading oculist" of a distant city, who in 1906 ordered:

R. + Sph. 0.75 + Cyl. 0.37 ax. 60°	} Distance.
L. + Sph. 1.00 + Cyl. 0.25 ax. 90°	
L. + S. 1.37 and Cyl. }	} Near.
R. + S. 1.12 and Cyl. }	

For a few weeks these felt comfortable, but then the old symptoms returned despite the diagnosis, antique, antiquarian, and though dead never buried, of "gout and rheumatism of the eye."

Oculist No. 7, myself, under cycloplegia diagnosed:

R. + Sph. 0.87 + Cyl. 0.37 ax. 70°	= 20/20?
L. + Sph. 1.00 + Cyl. 0.25 ax. 90°	= 20/20

with perfect muscular balance.

His greatest complaint, upon persistent questioning, is that he becomes suddenly blind, or nearly so, when looking at anything. Things fade out and become nearly or wholly invisible. Even in the street, in looking at a person, the bodily figure grows dim or invisible; when playing baseball, and watching the course of the ball in the air, it will disappear for a second or more and then again become visible. In order to see anything plainly he has to rub his eyes. In near vision it is more impossible to hold the image. The peculiar and persistent blepharospasm for twelve years, with the rapid fading of the image, seems to point to difficult holding of the retinal function due to faulty blood supply. Competent general physicians have examined him and pronounce him free from all recognizable systemic or organic disease.

Having in mind the case above described, I was quick to recognize the existence in this man's eyes of the anomalies of the network of the retinal veins and arteries. From the point of emergence or entrance at the disc they curled about each other, crossed and recrossed each other, in a manner to strike immediate attention. Description would be almost impossible. The upper temporal artery of the right eye crosses over the vein on the disc, and crosses under the vein twice after leaving the disc. The lower temporal artery crosses over the vein on the disc and does not recover full size and color for 30° below the disc. The upper temporal artery of the left eye passes over the vein on the disc, again passes under the vein on the disc, and once more passes under the vein about 40° from the disc. The lower temporal artery passes beneath the vein on the disc, passes over the vein 20° from the disc, and again over the vein 40° from the disc. The arteries

are smaller and thinner and lighter in color on the disc than toward the periphery, whereas the veins are turgid and swollen as they approach the disc. There was noteworthy general venous stasis, and venous pulsation was present. Both eyes were affected in the same way, but the right possibly in a more decided manner. I felt justified in ordering correct lenses, in explaining what I thought the cause of his symptoms, their incurability, and in urging a life-time renunciation of nearly all reading, writing, or near-work occupations.

It seems probable that in such intercrossing of blocked and choked vessels lessening the supply of arterial blood and serum, or preventing the normal out-passing of venous blood and lymph, we have the distinct cause of a new type of ocular disease, and especially of its results, another kind of incurable evestrain. The same or a similar result may be due to crowding of the vessels at the disc, as they turn, or within the optic nerve sheath itself, with venous pulsation, stasis, impaired nutrition, etc. Is it also not possible that such blocking and crowding may account for the rise of other retinal and intraocular diseases, the etiology of which is at present not clear? Such, *e.g.* as degenerative, pigmentary and atrophic macular diseases, the enlargement of the globe and the lessening of hyperopia, its passage into myopia, the change, during presbyopia, of 90° axes to 180° axes of astigmatism, all of which and more, are possible consequences of the lessened outflow and disturbed nutrition which would follow crossing and crowding of the vessels. Would not such causes constitute precisely the factors needed to clear up the etiology of the mysterious and terrible disease, glaucoma? It appears highly significant that the several greatest ocular diseases,

glaucoma, cataract, presbyopia, the reversal of the astigmatic axes, etc., should all be coincidental and fall upon the time of failing life-powers and lowered blood pressure. It is presumable that, etiologically, they may often depend upon the want of vascularization or full nutrition of the intraocular tissues, a process that even in the young has been of most difficult biologic accomplishment.

Even the greatest of all ocular diseases, astigmatism, and other forms of ametropia, with all the morbid results of eyestrain upon the general system, upon education, and social evolution, even these indirectly depend upon the shape of the eyeball, *i.e.* upon its tonicity, blood pressure, and nutrition. Astigmatism is largely dependent upon the pressure of the upper lid, which must rest upon the cornea at the upper border of the pupil, in order to shade the retina and thus aid in the reinstatement of its unstable equilibrium when impaired by every visual act. A greater tonicity would prevent the indentation by the lid, but it would prevent also the transmission of the nerve impulses and the currents of the blood, lymph, and serum; that is, a greater tonicity would be glaucoma.